Claims

[c1] 1.A fuel cell stack comprising:

a plurality of interconnects, each of said interconnects defining at least two openings and comprising at least one flow field for flowing a reagent, each of said at least two openings defining a respective fuel manifold, said fuel manifolds comprising at least one intake fuel manifold and at least one exhaust fuel manifold;

at least one fuel cell unit comprising an anode, a cathode, and an electrolyte disposed between said anode and said cathode, wherein said anode is positioned adjacent to a respective one of said interconnects and is configured to be in both electrical connection and fluid communication with said interconnect, said flow field of said interconnect being configured to guide a fuel flow from said at least one intake fuel manifold to said at least one fuel exhaust manifold, and wherein said cathode is positioned adjacent to another respective one of said interconnects and configured to be in both electrical connection and fluid communication with said another interconnect, said flow field of said another interconnect being configured to guide an oxidant flow across said another interconnect;

a perimeter isolation seal disposed around the respective one of said interconnects adjacent to said anode, said perimeter isolation seal being disposed on a side of said interconnect facing said anode and being configured to seal said electrolyte to said interconnect; and

at least two interior isolation seals disposed on the respective one of said interconnects adjacent to said cathode and on a side of said interconnect facing said cathode, one interior isolation seal surrounding each of said openings and being configured to seal said electrolyte to said interconnect.

[c2] 2.The fuel cell stack of Claim 1, wherein said at least one planar fuel cell unit comprises a solid oxide fuel cell.

[c3] 3.The fuel cell stack of Claim 1, comprising a plurality of planar fuel cell units arranged in a vertical stack.

[c4] 4.The fuel cell stack of Claim 3, wherein at least one pair of adjacent planar fuel

cell units share one of said interconnects, said interconnect being adjacent to and in both electrical connection and fluid communication with said anode of one of said planar fuel cell units and said cathode of the other of said planar fuel cell units.

[c5] 5.The fuel cell stack of Claim 3, wherein each of said at least one planar fuel cell units is polygonal.

[c6] 6.The fuel cell stack of Claim 5, wherein each of said at least one planar fuel cell units is rectangular.

[c7] 7.The fuel cell stack of Claim 5, wherein each of said at least one planar fuel cell units is hexagonal.

[c8] 8.The fuel cell stack of Claim 7, wherein each of said interconnects defines four openings which are arranged in two pairs positioned on two opposing ends of said interconnect, each pair defining an intake fuel manifold and an exhaust fuel manifold.

[c9] 9.The fuel cell stack of Claim 5, wherein each of said planar fuel cell units comprises a polygonal solid oxide fuel cell.

[c10] 10.The fuel cell stack of Claim 9, further comprising:
a top end plate disposed above an upper one of said planar fuel cell units; and
a bottom end plate disposed below a lower one of said planar fuel cell units.

[c11] 11.The fuel cell stack of Claim 9, wherein said electrolyte is substantially solid and is deposited onto said anode and the respective one of said interconnects, said perimeter isolation seal comprising said electrolyte and being formed by depositing said electrolyte on said interconnect.

[c12] 12.A fuel cell module comprising:
a vessel having an inlet and an outlet, said inlet and outlet being configured to receive and exhaust an oxidant, respectively;
at least three fuel cell stacks arranged in a ring within said vessel, said fuel cell stacks separating an inner and an outer volume of said vessel, said inner and outer volumes being in fluid communication through said fuel cell stacks, at

least one of said fuel cell stacks having a fuel inlet and at least one of said fuel cell stacks having a fuel outlet for receiving and exhausting a fuel flow, respectively, wherein each fuel cell stack comprises at least two fuel manifolds for receiving and exhausing the fuel flow and further comprises at least one planar high-temperature fuel cell unit comprising an anode, a cathode, and an electrolyte disposed between said anode and cathode, each fuel cell stack further comprising a plurality of compressive seals for segregating said cathode and the fuel flow through said fuel manifolds and for segregating said anode and the oxident; and

a plurality of electrical connections between said fuel cell stacks for electrically connecting each fuel cell stack to at least one other of said fuel cell stacks.

[c13] 13.The fuel cell module of Claim 12, wherein said vessel comprises a pressure vessel, and wherein said planar high-temperature fuel cell units comprise planar solid oxide fuel cell (SOFC) units.

[c14] 14. The fuel cell module of Claim 12, wherein said inlet is configured to receive the oxidant into said outer volume of said vessel and said outlet is configured to exhaust the oxidant from said inner volume of said vessel, and wherein each of said planar high-temperature fuel cell units is configured to convey the oxidant from said outer volume to said inner volume of said vessel.

[c15] 15.The fuel cell module of Claim 12, wherein said inlet is configured to receive the oxidant into said inner volume of said vessel and said outlet is configured to exhaust the oxidant from said outer volume of said vessel, and wherein each of said planar high-temperature fuel cell units is configured to convey the oxidant from said inner volume to said outer volume of said vessel.

[c16] 16.The fuel cell module of Claim 12, wherein each of said fuel cell stacks further comprises a plurality of interconnects, each of said interconnects defining at least two openings, each opening defining a respective one of said fuel manifolds, said fuel manifolds comprising at least one fuel intake manifold and at least one fuel exhaust manifold, and each interconnect further comprising at least one flow field for flowing a reagent,

wherein each anode is positioned adjacent to a respective one of said

interconnects and is configured to be in both electrical connection and fluid communication with said interconnect, and wherein said flow field of said interconnect is configured to guide the fuel flow from said at least one fuel intake manifold to said at least one fuel exhaust manifold,
wherein each cathode is positioned adjacent to a respective one of said interconnects and is configured to be in both electrical connection and fluid communication with said interconnect, said flow field of said interconnect being configured to guide an oxidant flow across said interconnect, and
wherein at least two of said interconnects in respective fuel cell stacks are electrically connected, providing said electrical connections between said fuel cell stacks.

[c17] 17.The fuel cell module of Claim 16, wherein said seals comprise:
a perimeter isolation seal disposed around the respective one of said interconnects adjacent to said anode, said perimeter isolation seal being disposed on a side of said interconnect facing said anode and being configured to seal said electrolyte to said interconnect; and
at least two interior isolation seals disposed on the respective one of said interconnects adjacent to said cathode and on a side of said interconnect facing said cathode, one interior isolation seal surrounding each of said openings and being configured to seal said electrolyte to said interconnect.

[c18] 18.The fuel cell module of Claim 17, further comprising a plurality of corner stack seals, each of said corner stack seals being disposed along an edge joining two of said fuel cell stacks, wherein each of the corner stack seals comprises a leaky seal.

[c19] 19.The fuel cell module of Claim 17, further comprising a plurality of corner stack seals, each of said corner stack seals being disposed along a face joining two of said fuel cell stacks, wherein each of the corner stack seals comprises a leaky seal.

[c20] 20.The fuel cell module of Claim 17, wherein each of said fuel cell stacks comprises a plurality of planar high-temperature fuel cell units arranged in a vertical stack, wherein each of said planar high-temperature fuel cell units is

disposed in one of a respective plurality of planes, and wherein said interconnects of at least two of said planar high-temperature fuel cell units in a respective plane are electrically connected.

[c21] 21. The fuel cell module of Claim 20, wherein at least one pair of adjacent planar high-temperature fuel cell units within each of said fuel cell stacks share a respective one of said interconnects, said interconnect being adjacent to and in both electrical connection and fluid communication with said anode of one of said planar high-temperature fuel cell units and said cathode of the other of said planar high-temperature fuel cell units.

[c22] 22.The fuel cell module of Claim 20, wherein each of said fuel cell stacks further comprises:
a top end plate disposed above an upper one of said planar high-temperature fuel cell units; and
a bottom end plate disposed below a lower one of said planar high-temperature fuel cell units.

[c23] 23.The fuel cell module of Claim 20, wherein all of said planar high-temperature fuel cell units within at least one of said planes are electrically connected.

[c24] 24.The fuel cell module of Claim 20, further comprising at least one heat exchanger connecting a pair of said fuel cell stacks and configured to supply the fuel flow exhausted from one of said pair of fuel cell stacks to a second of said pair of fuel cell stacks.

[c25] 25.The fuel cell module of Claim 24 comprising four fuel cell stacks arranged in a ring and at least two heat exchangers connecting said pair of fuel cell stacks and connecting a second pair of said fuel cell stacks, respectively,
wherein each of said planar high-temperature fuel cell units is rectangular, and wherein each of said pairs of fuel cell stacks includes a respective fuel inlet for receiving the fuel flow and a respective fuel outlet for exhausting the fuel flow, said fuel cell module further comprising:
a fuel feed line configured to supply said fuel inlets; and

a fuel exhaust line configured to exhaust said fuel outlets.

[c26] 26.The fuel cell module of Claim 25, wherein each of said pair and said second pair of said fuel cell stacks is electrically connected.

[c27] 27.The fuel cell module of Claim 25, wherein all of said fuel cell stacks are electrically connected.

[c28] 28.The fuel cell module of Claim 24, comprising six fuel cell stacks arranged in a ring and at least four heat exchangers connecting said pair of fuel cell stacks, and connecting a second, a third, and a fourth pair of said fuel cell stacks, respectively,
wherein each of said planar high-temperature fuel cell units is hexagonal,
wherein each of said pair and said second pair of fuel cell stacks includes a respective fuel inlet for receiving the fuel flow, and wherein each of said third and fourth pairs of fuel cell stacks includes a respective fuel outlet for exhausting the fuel flow,
said fuel cell module further comprising:
a fuel feed line configured to supply said fuel inlets; and
a fuel exhaust line configured to exhaust said fuel outlets.

[c29] 29.The fuel cell module of Claim 28, wherein two of said fuel cell stacks are electrically connected, wherein another two of said fuel cell stacks are electrically connected, and wherein a remaining two of said fuel cell stacks are electrically connected.

[c30] 30.The fuel cell module of Claim 28, wherein three of said fuel cell stacks are electrically connected, and wherein another three of said fuel cell stacks are electrically connected.

[c31] 31. The fuel cell module of Claim 28, wherein all of said fuel cell stacks are electrically connected together.